MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. XXXI. *February* 10, 1871. No. 4.

WILLIAM LASSELL, Esq., President, in the Chair.

T. G. E. Elger, Esq., Bedford; and
H. C. Russell, Esq., Superintendent of the Sydney Observatory,

were balloted for and duly elected Fellows of the Society.

Report of the Council to the Fifty-first General Meeting of the Society.

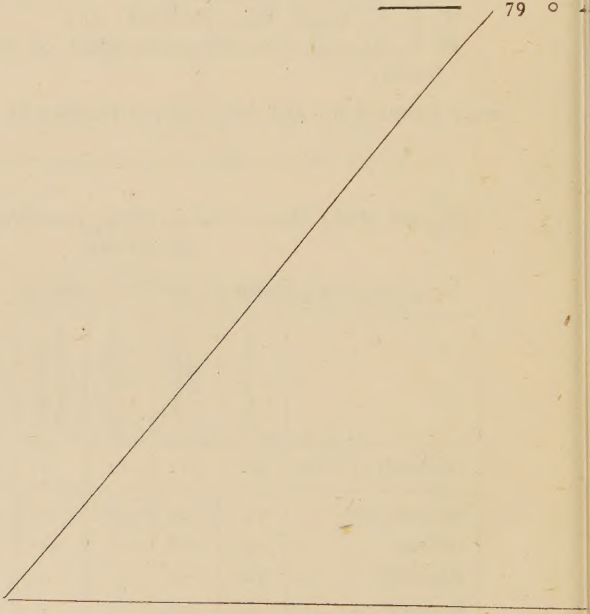
Progress and present state of the Society:—

	Compounders.	Annual Contributors.	Non-residents.	Patroness, and Honorary.	Total Fellows.	Associates.	Grand Total.
December 31, 1869	187	311	11	3	12	45	557
Since elected ...	+7	+18	...	...	...	...	...
Deceased	−4	−6	−1	..	...	−1	...
Removals	+2	−2	...	...	...	...	...
Resigned	...	−8	...	...	...	...	...
Names removed for non-payment of arrears, &c. ...	...	−8	...	...	...	...	...
Dec. 31, 1870 ...	192	305	10	3	510	44	554

Mr. Whitbread's Account as Treasurer of the Ro

RECEIPTS.

	£	s.	d.	£	s.
Balance of last year's account				102	17
By Dividend on £3400 Consols	49	18	9		
By ditto on £5000 New 3 per Cents ...	73	8	9		
By ditto on £3400 Consols	50	3	0		
By ditto on £5000 New 3 per Cents ...	73	15	0		
				247	5
On account of arrears of contributions ...	179	11	0		
186 annual contributions	390	12	0		
24 admission-fees	50	8	0		
17 first years' contributions	28	7	0		
				648	18
9 compositions			...	189	0
Sale of publications:—					
At the Rooms of the Society	41	3	0		
By Messrs. Williams and Norgate, Publishers	37	17	4		
				79	0



£1267 1 4

stronomical Society, from January 1 *to December* 31, 1870.

EXPENDITURE.

	£	s.	d.	£	s.	d.
Salaries:—						
Editor of Publications	60	0	0			
Assistant Secretary	130	0	0			
Commission on Collecting 690*l.* 1*s.*	34	10	0			
				224	10	0
Taxes:—						
Land and Assessed	6	11	0			
Income	2	1	8			
Poor Rate	5	12	6			
Other Parish Rates	5	12	6			
				19	17	8
Bills:—						
Strangeways and Walden, printers ...	510	4	10			
Rumfitt, bookbinder	22	6	8			
Malby and Co., engravers	11	18	0			
W. Metcalf ditto	29	14	9			
Troughton and Simms	7	0	0			
Insurance	7	15	6			
Dr. Brünnow	30	0	0			
				618	19	9
Miscellaneous items:—						
House expenses	23	17	10			
Postages	40	14	8			
Books and parcels	4	17	1			
Expenses of evening meetings	13	13	0			
Waiters attending meetings	3	17	0			
Coals and wood	12	0	0			
Gas	6	9	8			
Repairs	2	12	6			
Sundries	9	10	9			
				117	12	6
				980	19	11
Lee Fund	5	0	0			
Turnor Fund	1	19	3			
Mrs. Jackson Gwilt's annuity, 1 year ...	8	16	0			
				15	15	3
				996	15	2
Banker, New Cheque Book				0	5	0
				997	0	2
Balance at Banker's				270	1	2
				£1267	1	4

Examined and found correct, Jan. 27, 1871,

(Signed) H. Perigal,
F. C. Penrose,
W. B. Gibbs,
} *Auditors.*

Assets and Present Property of the Society, January 1, 1871 :—

				£	s.	d.	£	s.	d.
Balance at Banker's				...		...	270	1	2
1	Contribution of 9 years' standing		...	18	18	0			
3	,,	7	,, ...	44	2	0			
7	,,	6	,, ...	88	4	0			
5	,,	5	,, ...	52	10	0			
14	,,	4	,, ...	117	12	0			
13	,,	3	,, ...	81	18	0			
19	,,	2	,, ...	79	16	0			
29	,,	1	,, ...	60	18	0			
Balance of an Account...				4	14	0			
							548	12	0
Due for Publications				...		...	2	7	0
£5000 New 3 Per Cents (including Mrs. Jackson's Gift, £300).									
£3400 Consols, including the Lee Fund (£100) and Turnor Fund (£500).									
Unsold Publications of the Society.									
Various astronomical instruments, books, prints, &c.									
Balance of Turnor Fund (included in Treasurer's Account)							152	12	9

Stock of volumes of the *Memoirs* :—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	12	XIII.	199	XXVII.	456
I. Part 2	52	XIV.	392	XXVIII.	416
II. Part 1	70	XV.	174	XXIX.	448
II. Part 2	34	XVI.	200	XXX.	297
III. Part 1	86	XVII.	183	XXXI.	173
III. Part 2	105	XVIII.	177	XXXII.	204
IV. Part 1	103	XIX.	184	XXXIII.	208
IV. Part 2	114	XX.	180	XXXIV.	196
V.	126	XXI. Part 1	216	XXXV.	169
VI.	152	XXI. Part 2	100	XXXVI. (with M. N.)	255
VII.	176	XXI. (together).	91	XXXVI. (without)	47
VIII.	162	XXII.	182	XXXVII. Part 1	518
IX.	165	XXIII.	177	XXXVII. Part 2	476
X.	175	XXIV.	183	XXXVIII.	494
XI.	185	XXV.	196		
XII.	190	XXVI.	201		

The instruments belonging to the Society are as follows:—

The *Harrison* clock,
The *Owen* portable circle,
The *Beaufoy* circle,
The *Beaufoy* transit,
The *Herschelian* 7-foot telescope,
The *Greig* universal instrument,
The *Smeaton* equatoreal,
The *Cavendish* apparatus,
The 7-foot Gregorian telescope (late Mr. Shearman's),
The Variation transit (late Mr. Shearman's),
The Universal quadrant by Abraham Sharp,
The *Fuller* theodolite,
The Standard scale,
The *Beaufoy* clock, No. 1,
The *Beaufoy* clock, No. 2,
The *Wollaston* telescope,
The *Lee* circle,
The *Sharpe* reflecting circle,
The *Brisbane* circle,
The *Baker* universal equatoreal.
The *Reade* transit.

The *Sheepshanks'* collection of instruments, viz.,—

1. 30-inch transit, by Simms, with level and two iron stands.

2. 6-inch transit theodolite, with circles divided on silver; reading microscopes, both for altitude and azimuth; cross and siding levels; magnetic needle; plumbline; portable clamping foot and tripod stand.

3. $4\frac{6}{10}$ achromatic telescope, about 5 feet 6 inches focal length; finder, rack motion; double-image micrometer; object-glass micrometer; two other micrometers; one terrestrial and ten astronomical eyepieces, applied by means of two adapters, with equatorial stand and clock movement.

4. $3\frac{1}{4}$-inch achromatic telescope, with equatorial stand; double-image micrometer; one terrestrial and three astronomical eyepieces.

5. $2\frac{3}{4}$-inch achromatic telescope, with stand; one terrestrial and three astronomical eyepieces.

6. $2\frac{1}{4}$ achromatic telescope, about 30 inches focus; one terrestrial and four astronomical eyepieces.

7. 2-foot navy telescope.

8. 45-inch transit instrument, with iron stand, and also Y's for fixing to stone piers; two axis levels.

9. Repeating theodolite, by Ertel, with folding tripod stand.

10. 8-inch pillar-sextant, divided on platinum, with counterpoise stand and horizon roof.

11. Portable zenith instrument, with detached micrometer and eyepiece.

12. 18-inch Borda's repeating circle, by Troughton.

13. 8-inch vertical repeating circle, with diagonal telescope, by Troughton and Simms.

14. A set of surveying instruments, consisting of a 12-inch theodolite for horizontal angles only, with extra pair of parallel plates; tripod staff; in which the telescope tube is packed; repeating table; level collimator, with micrometer eyepiece; and Troughton's levelling staff.

15. Level collimator, plain diaphragm.

16. 10-inch reflecting circle, by Troughton, with counterpoise stand; artificial horizon, with metallic roof; two tripod stands, one with table for artificial horizon.

17. Hassler's reflecting circle, by Troughton, with counterpoise stand.

18. 6-inch reflecting circle, by Troughton, with two counterpoise stands, one with artificial horizon.

19. 5-inch reflecting circle, by Lenoir.

20. Reflecting circle, by Jecker, of Paris.

21. Box sextant and 3-inch plane artificial horizon.

22. Prismatic compass.

23. Mountain barometer.

24. Prismatic compass.

25. 5-inch compass.

26. Dipping needle.

27. Intensity needle.

28. Ditto ditto.

29. Box of magnetic apparatus.

30. Hassler's reflecting circle, with artificial horizon roof.

31. Box sextant and $2\frac{1}{4}$-inch glass plane artificial horizon.

32. Plane speculum artificial horizon and stand.

33. $2\frac{1}{2}$-inch circular level horizon, by Dollond.

34. Artificial horizon roof and trough.

35. Set of drawing instruments, consisting of 6-inch circular protractor; common ditto; 2-foot plotting scale; two beam compasses and small T square.

36. A pentagraph.

37. A noddy.

38. A small Galilean telescope, with the object lens of rock-crystal.

39. Six levels, various.

40. 18-inch celestial globe.

41. Varley stand for telescope.

42. Thermometer.

43. Telescope, with the object-glass of rock crystal.

These are now in the apartments of the Society, with the exception of the following, which are lent, during the pleasure of the Council, to the several parties under mentioned, viz.:—

The *Fuller* theodolite, to the Director of the Sydney Observatory.

The *Beaufoy* transit, to the Observatory, Kingston, Canada.

The *Sheepshanks* instrument,		No. 1, to Mr. Lassell.
Ditto	ditto	No. 2, to Mr. Huggins.
Ditto	ditto	No. 3, to Mr. Brothers for the Eclipse Expedition.
Ditto	ditto	No. 4, to Rev. C. Lowndes.
Ditto	ditto	No. 5, to Mr. Birt.
Ditto	ditto	No. 6, to Rev. J. Cape.
Ditto	ditto	No. 8, to Rev. C. Pritchard.
Ditto	ditto	No. 9, to the Director of the Sydney Observatory.
Ditto	ditto	No. 41, to Rev. C. Pritchard.
Ditto	ditto	No. 43, to Mr. Huggins.

The 6-inch circular protractor, to Mr. Birt.

Printed Transactions of the Society.

Memoirs.

Part II. of Volume XXXVII., and Volume XXXVIII. of the *Memoirs* have been published since the last Annual Report. They contain the following papers, all of which are printed *in extenso*.

Volume XXXVII., Part II.:—

1. "On a Determination of the Direction of the Meridian with a Russian Diagonal Transit Instrument." By Capt. A. R. Clarke, R.E., F.R.S.

The instrument with which these observations were made was constructed for the Royal Observatory, Greenwich, by M. Brauer, of the Imperial Observatory, at Pulkowa, in such a manner that the rays of light, after passing through the object-glass, are bent at right-angles by a prism placed in the central tube, and then pass out at one of the pivots. The great advantage derived from an instrument of this construction is that the transit of an object at any altitude can be made without altering the position of the observer's head. This Russian transit was used, under the direction of Capt. Clarke, at Findlay Seat, a mountain in Elginshire, from October 13 to 31, 1868, for the special purpose of determining the true direction of the Meridian. The detailed results of the observations are given in the paper, and they give strong evidence in favour of the stability and excellence of the instrument.

2. "A Determination of the Constant of Nutation from the Observations in N.P.D. of *Polaris*, *Cephei* 51, and δ *Ursæ Minoris*, made with the Transit-circle of the Royal Observatory, Greenwich, 1851–65." With an Addendum containing "A De-

termination of the Constant of Nutation from the Observations of *Polaris* in Right Ascension." By E. J. Stone, Esq., M.A., F.R.S.

In this investigation Mr. Stone has availed himself of the results of all the observations of the above Polar stars in N.P.D. and of the deduced Right Ascensions of *Polaris* only, which appear in the "Ledgers" of the *Greenwich Observations* from 1851 to 1865. Special care has been taken to make the corrections for division-errors, astronomical flexure, and zenith points in the different years under one uniform system. The mean value of the constant as determined by Mr. Stone from the four series of observations is $9''{\cdot}134$, or $0''{\cdot}090$ less than Professor Peters' value published in *Numerus Constans Nutationis*. Tables containing the details of the computations are appended to the Paper.

Volume XXXVIII.:—

1. "Seventh Catalogue of Double Stars, observed at Slough, in the years 1823–28 inclusive, with the 20-feet Reflector; 84 of which have not been previously described." By Sir J. F. W. Herschel, Bart., F.R.S.

This Catalogue contains a number of double stars which were observed by Sir John Herschel in the course of his earlier stellar sweeps at Slough, and which, for various reasons, were omitted in preceding catalogues. Many of the estimated angles of position, Sir John Herschel considers, possess a considerable historical value, inasmuch as in many instances they were made at a date anterior to any recorded measurements, while others are the only existing records of position. This Catalogue, therefore, forms a valuable addendum to the previous Double-Star Catalogues of that accomplished observer.

2. "On the Determination of the Orbit of a Planet from Three Observations." By Professor Cayley, F.R.S.

This valuable mathematical paper is drawn up by Professor Cayley in considerable detail, and occupies the principal portion of the volume. The first sections are devoted to considerations on the general theory of the problem, followed by formulæ and deductions, illustrated by five lithographic plates.

Monthly Notices.

In addition to the preceding Papers, several others of equal interest are printed in full, or in abstract, in the *Monthly Notices*. Some of these are made the subject of special remark in another section of the Report.

General Index to the Monthly Notices.

In consequence of a frequently-expressed want of a means of more easy reference to the Papers and reports in the volumes of the *Monthly Notices*, the Council requested the Assistant-Secretary, Mr. Williams, to prepare a General Index of Volumes

I.–XXIX., which included the whole series at the time of going to press. The work of compilation was a laborious one, for it consisted not only of arranging the annual indexes into one index, but also of making a considerable number of additional entries both of names and subjects. The Index was placed in the hands of the Fellows in November last, and its value has been acknowledged by those who have had occasion to refer to it.

Obituary.

The Society has to regret the loss by death of the following Fellows and Associate:—

Fellows:—Prof. E. W. Brayley.
Mr. C. Mason.
Admiral Manners.
Mr. H. Boys.
Sir F. Pollock.
Rev. Dr. Gwatkin.
Mr. G. R. Smalley.
Mr. J. G. Perry.
Mr. C. D. Archibald.
Mr. C. Frodsham.
Lieut.-Gen. Sir W. T. Denison, K.C.B.
Mr. H. Barrow.

Associate:—Prof. H. Selander.

Russell Henry Manners was born in London on the 31st of January, 1800. He was the only child of the late Mr. Russell Manners, M.P. Having in early life evinced a desire for the naval profession, he was placed at the Royal Naval College on the 6th of May, 1813, where he remained until he completed the course of instruction which was to qualify him for his future career. On the 6th of March, 1816, he embarked as a volunteer on board the Minden, 74, Captain Paterson, in which, after assisting at the bombardment of Algiers, he proceeded to the East Indies. During his residence in India he served under the flag of Sir Richard King. On the 1st of July, 1818, he was nominated midshipman to the Orlando, 36, commanded by Captain John Clavell, with whom, in 1819, he returned to England in the Malabar, 74. After an intermediate employment on the Channel and West India stations in the Spartan and Pyramus frigates, under Captains William Furlong Wise and Francis Newcombe, he became, on the 29th of July, 1822, acting Lieutenant of the Tyne, 26, Captain John Edward Walcot, to which ship the Admiralty confirmed him on the 19th October following. In May, 1823, he rejoined the Pyramus, still commanded by Captain Newcombe, under whom he continued until he obtained his promotion on the 16th of August, 1825. His last appointment was on the 21st of October, 1827, when the command

of the Britomart, 10, was assigned to him. The Britomart was first employed in the Channel service under the order of the Earl of Northesk, Commander-in-Chief, at Plymouth. She accompanied the squadron of ships escorting Don Miguel to Lisbon in the early part of 1828. In consequence of the revolution that followed in Portugal on Don Miguel declaring himself absolute, the Britomart was stationed off Oporto to watch the British interests there. The Constitutional party, failing to restore the Constitution against the usurped position of Don Miguel, the British Government withdrew her Minister from Lisbon, leaving the British interests in the hands of the Consul only, and Captain Manners was selected to be in readiness to support him in case of need, by keeping in sight of signals from Lisbon as long as the safety of the vessel permitted, but not to anchor within any Portuguese port unless absolutely necessary. This involved a long and vigilant cruising off and on the coast for about eight months, and through the whole of the winter. The only place communicated with during that time was Gibraltar, and then only to receive a supply of provisions and water from the dockyard. The yellow fever unfortunately breaking out at Gibraltar just before going there for this object, no communication could be had with the town, and the stay was confined to from twenty-four to forty-eight hours. The zeal and ability with which this service was carried out by Captain Manners, as witnessed by Sir George Sartorius, then in command of the Portuguese Constitutional Squadron, and under whose orders in some degree the Britomart was placed, led to Captain Manners receiving his Post-rank on the 4th of March, 1829. He retired from active service in March, 1849, became Rear-Admiral in July, 1855, Vice-Admiral in 1862, and Admiral in September, 1865. In 1834 he married Louisa Jane, daughter of the Count de Noé, Peer of France.

From the time he obtained his Post-rank to the time of his death, the subject of our memoir devoted much of his attention to scientific pursuits. He was elected a member of the Royal Astronomical Society in 1836. At a very early period he took an active interest in its administration, and after being on the Council for some time, was elected one of the Honorary Secretaries in February 1848, an office which he filled until 1858, when he accepted that of Foreign Secretary. This was a post for which his knowledge of foreign languages and his position in society peculiarly fitted him, and during his tenure of office he formed by active correspondence a connecting link between English and foreign Astronomers. He was much esteemed on the Continent and in America. In connection with this circumstance it may be remembered that one of the Presidents of the Society, in asking Admiral Manners to transmit one of the Society's Medals to a foreign recipient, deemed it just to preface his remarks with the following well-deserved compliment:—

"Admiral Manners,—It has been my good fortune to visit the majority of European observatories, and to make the acquaintance

of their Directors and other gentlemen connected with them, and it has in consequence become known to me how high in their esteem our Foreign Secretary stands. Your urbanity and promptitude in carrying out our foreign business has indeed become proverbial."

Admiral Manners was, on more than one occasion, asked to accept the chair of President, which, after some hesitation, he consented to do, and he was elected to that position in 1868. None of his predecessors was more highly esteemed by the Fellows of the Society, and no one filled the Chair more admirably than he did. His mathematical attainments were considerable, more so than one might have inferred from his quiet demeanour. He was well versed in the astronomical literature of the day, and took a deep interest in the progress of astronomical science, both in England and on the Continent; and his active influence was always available for the promotion of any object connected with it.

On presenting the Gold Medal of the Society to Mr. Stone, First Assistant of the Royal Observatory, Greenwich, Admiral Manners delivered a most exhaustive summary of that astronomer's labours, and evinced a complete knowledge of the history of the Solar Parallax, for the investigation of which the Medal was mainly awarded. Illness overtook him before he could complete his second year of office, and he was compelled to forego the gratification of delivering the Address to M. Delaunay for his researches on the Lunar Theory; but he made it a point of duty and pleasure to receive M. Delaunay at his house, and although he was compelled to delegate to the friendly hand of Professor Adams the drawing up of the Address, yet he read and approved of what was written before it was delivered. As the season advanced he gradually grew weaker, and finally expired on the 9th of May, 1870. He was supported in his last moments by a sincere and profound belief in the truths of the Christian religion. Mrs. Manners survives him; also two sons and a daughter.

Admiral Manners was distinguished by an affability and kindliness of disposition which procured for him the sincere esteem of all with whom he came in contact, and especially endeared him to those who enjoyed the privilege of his intimate friendship. In this Society where he was so long and so well known the many excellent qualities of head and heart which appeared so conspicuous in our late President will long be cherished with affectionate remembrance.

The Right Hon. Sir Frederick Pollock, Bart., of Scottish extraction, was born in London, September 23rd, 1783. He was the third son of Mr. David Pollock—three of whose five sons acquired great distinction in their respective callings. The eldest (Sir David) was Chief Justice of Bombay; the youngest (Sir George) is now a Field Marshal—this honour having been lately conferred upon him for his exploits in Affghanistan and

other well-fought fields. Sir Frederick, as is well known, occupied for upwards of twenty years the high position of Chief Baron of the Court of Exchequer, having succeeded Lord Abinger in the year 1844, when he was sworn a member of Her Majesty's Privy Council. Shortly after his retirement, in June, 1866, he was created a Baronet. The steps by which Sir Frederick fought his way up from a comparatively humble position to one of high distinction are interesting, as affording evidence of what may be accomplished when natural talent has coupled with it a determined will and an untiring industry.

Sir Frederick went from St. Paul's School to Trinity College, Cambridge, where he early distinguished himself, and at the end of his third term passed in the first class. Pecuniary considerations then made him think of retiring from Cambridge, but, through the kindness of his tutor, the Rev. George F. Tavel, the obstacles to his remaining at Cambridge were overcome, and this gentleman had the gratification of seeing his *protégé* come out senior wrangler of his year, 1806.

In 1807 he was called to the bar, and in three years from that date he was in extensive practice. He received a silk gown in 1827, having already attained the greatest success in his profession. For many years he led the Northern circuit, and was retained in all the most important cases. In May, 1831, he became member for Huntingdon, and was promoted, under Sir Robert Peel's administration, to the office of Attorney-General. He held his seat in Parliament until his elevation to the Bench in 1844.

Although his mind was necessarily to a great extent absorbed by the duties of his office, Sir Frederick never lost his interest for mathematical and general science; his reading in most branches of human knowledge was extensive and profound, and he ever evinced a lively interest in the most recent scientific investigations. He took, for example, a great interest in the various photographic discoveries, and although he left to his talented son (Mr. Henry Pollock) the actual practice of the art, he used all his influence to foster it, and was for many years the President of the Photographic Society. Within a few weeks of his death he was engaged on a mathematical paper, which he proposed to communicate to the Royal Society, of which he had been a fellow since February 1816, and to whose Transactions he had contributed several mathematical papers, among others, "On a Method of Proving the three leading Properties of the Ellipse and Hyperbola."

A man so much otherwise engaged could not be expected to contribute directly to astronomical discovery; but he kept himself always well informed of the progress of our science, and even to a very late period made observations with his telescope. When spectroscopic discoveries promised to throw light on solar physics, he acquired a spectroscope, so as to follow them practically.

Sir Frederick married twice, and has left a family of twenty children. Several of his sons have already distinguished themselves. The present Sir Frederick is one of the masters of the Court of Exchequer.

The late Sir Frederick Pollock died at Hatton, on the 22nd of August, 1870, in his 87th year.

Charles Frodsham was born on April 15th, 1811. He was the third son of the late Mr. W. J. Frodsham, the eminent chronometer-maker, who, while he devoted himself to the higher branches of his own art, took an active part in the promotion of general science, and attained the honour of admission as a fellow of the Royal Society. Mr. Charles Frodsham was brought up to his father's business, and showed in his early manhood a remarkable faculty for undertaking the more minute and intricate calculations involved in the construction and regulation of chronometers. In 1847 Mr. Frodsham was presented with the Telford medal, for a paper on the Isochronism of the Balance Spring, and was also complimented on the same occasion by being made an Associate of the Institution of Civil Engineers. In 1862 Mr. Frodsham was appointed a Juror in Class XV. in the London International Exhibition, and being elected Reporter to the same, he published on the adjudication of the prizes a very clever and exhaustive report on "Chronometers, Watches, and Clocks." He was also in this same year the author of another treatise entitled "A few Facts connected with the Elements of Clock and Watchmaking." Mr. Frodsham served twice as master of the Clockmakers' Company. He was also appointed a Juror of the Dublin Exhibition in 1865, and both as Juror and Vice-President of the Paris Exhibition in 1867; although excluded by his position as Juror from all competition on these occasions, he gained eleven medals, among which was the grand gold medal of the Emperor of Russia. These various labours were achieved, and these distinctions won in spite of ill health and of an extreme delicacy of the lungs, from which he suffered through life. Mr. Frodsham was several times a member of the Council of the Royal Astronomical Society. In private life Mr. Frodsham was of a genial and lively temperament, cheerful under bodily ailments, and well stored with general information. In public life his name will ever be honourably associated throughout the civilised world with his particular art. He is justly entitled to take his place in the age in which he lived, as one of the most distinguished of English watch, clock, and chronometer makers.

Charles Mason was born on the 5th of February, 1823, at Stoke Pogis, Buckinghamshire. His only education was received at the village school. In 1846 he obtained employment in a subordinate capacity at one of the small stations of the London and Brighton Railway, and during the remainder of his life he held some office more or less important in connexion with

the railway interest. Gradually working his way, as the result of his active business habits, he, in 1855, became Superintendent of the York district of the North Eastern Railway. This appointment he subsequently exchanged for that of General Manager of the Birkenhead Railway, which he held about two years, when his successful management attracted the attention of the Directors of the London and North-Western Railway, who secured his services in the important position of Goods Manager of that undertaking. This office he retained till his appointment as Assistant General Manager of the same Company. Although Mr. Mason was a self-made man, having risen from comparative obscurity to the responsible position of sub-manager of the most influential railway company in the country, yet he was a person of cultivated mind, having always a keen taste for the beautiful in art, and an ardent love for science, especially for astronomy. His astronomical inclinations led him to seek the Fellowship of the Royal Astronomical Society, to which he was elected on the 14th of February, 1862. Mr. Mason was a first-rate man of business, and was greatly respected by all with whom he was brought into contact on railway affairs; for his frank and genial manners made him one of the most popular of railway men,and his death was universally deplored. Mr. Mason died at his residence, 22 Albert Road, Regent's Park, on the 14th of September, 1869, in the forty-seventh year of his age, leaving a wife, two sons, and a daughter, to mourn his loss. His funeral in the churchyard of Stoke Pogis was attended by more than a hundred of his railway friends, who have erected a memorial-stone over his grave as a mark of the respect in which they held him.

The late JOHN GEORGE PERRY was born on the 3rd of May, 1802. He was a pupil of the celebrated Surgeon Henry Earle, and commenced his professional career at St. Bartholomew's Hospital, of which he subsequently became a governor. For many years Mr. Perry was surgeon of the St. Marylebone Infirmary, and in 1829 he succeeded Mr. Earle as surgeon of the Foundling Hospital, a post which he held for fourteen years. In 1834 he was elected a governor, and continued a member of the committees of management of that institution and of St. Bartholomew's until his death, always taking an active part in promoting their interests.

He was for six years secretary to the Royal Medical Chirurgical Society during the presidency of Sir Benjamin Brodie. In 1843 he was appointed, at the recommendation of Sir Benjamin Brodie, an inspector of prisons, when he retired from his profession as a surgeon, much to the regret of his colleagues and friends.

In his new career he displayed the same assiduity and zeal which had always characterised him, and he received the commendations of Sir James Graham in the House of Commons for his public services. One of his most beneficial recommendations was the incorporation of a large number of the smaller borough

prisons into the county prisons, thereby placing the prisons under more efficient management, and effecting a great saving of expense. He was appointed one of the visitors of the prison for juvenile offenders at Parkhurst, and one of the commissioners of Millbank prison.

Notwithstanding his official duties, Mr. Perry took an active interest in several branches of science; for some time he was on the Council of the Zoological Society. Although his avocations prevented him from making regular astronomical observations, he, nevertheless, made himself well acquainted with astronomical phenomena, and availed himself of such opportunities as a London residence permitted for familiarising himself with such objects as could be studied with a $3\frac{1}{2}$-inch telescope. In 1860 he took part in the Himalaya Eclipse Expedition, and made some observations from his station near Burgos.

Owing to the impaired state of his health, Mr. Perry felt it necessary to resign his appointment in the summer of 1869, and after much bodily suffering he died at the age of sixty-seven, in January 1870.

Arthur Kett Barclay* was born on the 20th of June, 1806. He was educated at Harrow, having previously been instructed by a tutor, under whom he acquired much information in chemistry and geology. During the years 1829 to 1833 he made the tour of north and south Europe. In early life he was much associated with Faraday, and subsequently became a Fellow of the Astronomical, Geological, and Geographical Societies; and in 1852 was elected a Fellow of the Royal Society. At the age of twenty he was actively engaged in the brewery of Barclay, Perkins, and Co., where he continued an acting partner until nearly the end of his life.

He was one of the treasurers to the Commissioners of the Great Exhibition of 1851. He was a magistrate and deputy-lieutenant of the county of Surrey, and was also captain of the Dorking troop of yeomanry until the regiment was disbanded in 1837.

He took an active part in the politics of the country as a strong Conservative, though he would never consent to be brought forward as a candidate.

He studied astronomy for some years at Norbury, near Croydon, where he had a small observatory of his own construction. In 1848 he built the observatory at Bury Hill. The revolving dome was by Ransomes and May of Ipswich, and the equatorial 8-inch object-glass by Troughton and Simms.

Though much engaged in business and county work, he assiduously continued his observations until he was struck down by paralysis in 1855. Happily his mind was not affected, though he never again was able to continue his work; and after nearly

* This obituary notice of Mr. A. K. Barclay was received too late for insertion in the last Annual Report.

fifteen years of a precarious life, he at last sank under another attack.

Proceedings of various Observatories.

Royal Observatory, Greenwich.

The work at the Royal Observatory since the date of the last Report has been of the same character as in previous years, the Moon being considered still the most important subject of observation.

During the past year the usual meridional observations of the Sun, Moon, and Planets, have been made with the Transit Circle, whilst the Moon has been observed with the altazimuth on every available opportunity, together with a high star and the collimator for the determination of the instrumental errors.

For the last four months the observations of the small planets have been continued all through the lunation, instead of merely in the first half, as it appeared probable that no observations would be made in Paris during the continuance of the siege. This has necessarily pressed rather heavily on the observers, though no serious inconvenience has been experienced in consequence, notwithstanding the absence of Mr. Carpenter on Dr. Huggins' Oran Expedition.

Two satisfactory series of observations of the Solar Eclipse have been made with the great equatoreal and with the altazimuth respectively, the reduction of which has thrown a large amount of extra labour on the computing staff of the Observatory, though the usual reductions have proceeded without interruption. Although dense clouds obscured the Sun in the early part of the the eclipse, numerous measures of the differences of R. A. and N.P.D. of the limbs of the Sun and Moon and of the differences of N. P. D. of the cusps were taken with the former instrument during the progress of the eclipse, in accordance with a carefully-arranged plan of observation. From these the corrections to the tabular differences of R. A. and N. P. D., and to the semi-diameters of the Sun and Moon (the latter, of course, affected with twice the amount of irradiation) have been deduced with great accuracy. The errors of Hansen's Tables appear from these observations to be sensibly the same near conjunction as in other parts of the Moon's orbit.

With the altazimuth three sets of double azimuths of the Moon's second limb and six of the first limb, together with three pairs of zenith distances of the upper limb were taken while the Moon was on the Sun's face, giving the diameter in azimuth as well as the tabular error in Right Ascension and North Polar Distance. This determination of the diameter, combined with measures of the azimuthal diameter of the bright Moon previously taken, will, it is expected, give data for obtaining the amount of solar or lunar irradiation in this instrument.

The proposed observations with the Transit Circle were lost through cloud at the time of transit, which is the more to be regretted as but few observations of the Sun are available to determine the correction to his tabular place about the time of the eclipse, which is required in the differential observations with the great equatoreal in order to deduce the error of the lunar tables.

From the same cause the first contact was lost; the times of last contact observed with various telescopes show the usual discordances due to difference of instrumental power.

The new water-telescope, for the determination of the effect on the co-efficient of aberration (as given by observations of *γ Draconis*) of the passage of the rays of light through a column of water, has been brought into working order, after some trouble experienced in securing the freedom from constraint of the object-glass, which is in contact with the upper surface of the water. A succession of cloudy days for some time prevented any regular observations with the instrument, whilst the risk of frost on the approach of winter soon rendered the removal of the water necessary until the weather should become more settled. Practically, however, the observations will be confined to those seasons of the year when *γ Draconis* passes the meridian about 6 A.M. and 6 P.M., at which time the greatest effects due to the aberration are observed. The observations will, therefore, shortly be resumed.

Ever since the erection of the transit-circle a gradual subsidence of the eastern support has been noticed, necessitating the application of a rather large correction for level. In order to remedy this inconvenience, as no adjustment of the Y is provided, about a ton weight of stone was placed on the western pier, but without producing the slightest appreciable effect—a good proof of the great stability of this instrument. As the western support could not be lowered, the plan was adopted of raising the eastern, for which purpose the Y was raised from its bed, and a sheet of thin paper, $\frac{1}{270}$-inch in thickness, placed under it, after which the level error was found to have been reduced by the quantity required, viz. $10''$, whilst by means of the collimators the Y was replaced without sensibly affecting the azimuthal error.

The New Seven Year Catalogue of Stars observed with the transit circle from 1861, Jan. 1, to 1867, Dec. 31—all reduced to the epoch 1864, Jan. 1—has been printed and distributed, as well as the volume of *Greenwich Observations* for the year 1868.

Independently of its intrinsic value, as affording standard points of reference for differential observations, it is hoped that this Catalogue will prove of great value to astronomers, as giving reliable data for determining the proper motions of *all* the stars observed by Bradley, and given in Bessel's *Fundamenta Astronomiæ*, many of which have not been included in previous catalogues.

The printing of the Astronomical portion of the Volume for 1869 has been proceeding more rapidly than usual, and is now,

with the exception of some few sections, quite finished, whilst the reductions of the observations are nearly complete to the end of the year 1870.

In August last the Observatory lost the able services of Mr. Stone, on his appointment by the Admiralty to the important office of Astronomer at the Cape of Good Hope, on the resignation of Sir Thomas Maclear. He has been succeeded as chief assistant by Mr. W. H. M. Christie, B.A., of Trinity College, Cambridge.

Cambridge Observatory.

The transit instrument was dismounted in the course of the year 1869, and preparations were made for the mounting of the transit circle in the place of it.

Unexpected difficulties which Mr. Simms met with, however, in constructing the new instrument, long delayed its completion, so that it was not ready till October 1870. Mr. Simms completed the mounting of it in December; and the first assistant, Mr. Graham, is now engaged in the determination of wire intervals and other elements of reduction, and in the examination of the circle and pivots.

Prof. Adams believes that this instrument, for which the Observatory is indebted to the munificence of Miss Sheepshanks, will prove to be one of the finest of its class. The object-glass of the telescope is an excellent one, by Cooke, of 8 inches aperture. There are two divided circles of 3 feet in diameter, one of them being fixed relatively to the axis of the telescope, and the other moveable and capable of being clamped to the axis in any position. Each of the divided circles is read off by means of four micrometer microscopes, and additional microscopes, if required, may be readily applied. There are two collimating telescopes, each of 6 inches aperture, which can be directed upon each other through an opening in the central cube. A powerful apparatus is likewise provided by which the instrument may be readily and safely reversed. There are no screw adjustments for azimuth and level, but the axis of the instrument is brought into its definitive position by scraping the Y supports.

The meridian observations having been necessarily interrupted, the work done in the Observatory during the past year has been chiefly confined to the reduction of the observations and to the preparation for the press.

The Transit and Circle Observations for several years are now arranged for the press, as well as all the Equatoreal Observations of Comets and Occultations.

The printing of the Observations has commenced, and having such a large mass of materials ready, Prof. Adams hopes that it will now proceed rapidly.

The meteorological observations have been made at the usual hours of 9 A.M. and 3 P.M.

Radcliffe Observatory, Oxford.

The Radcliffe Observatory has, in the past year, as in the one preceding, suffered by the death of a valuable assistant. Mr. Béchaux, whose appointment to the office of second assistant was notified in the last Annual Report of the Society, died suddenly on the 13th of August last, of heart disease. He had devoted himself so vigorously to astronomy, that his death may be considered as affecting its interests generally as well as the Radcliffe Observatory, which has felt his loss severely. It is, however, gratifying to be informed that the vacant situation has been ably filled by Mr. Gabriel Keating, formerly employed at Greenwich and well recommended by the Astronomer Royal, and that his services are likely to be valuable to the Observatory.

The work performed during the past year is of the same character and of about the same amount as in preceding years. The 27th volume of the *Radcliffe Observations* for 1867 was published and distributed in July last, and the printing of the Astronomical portion of the volume for 1868 is nearly completed. The Catalogue of Stars, in number 1772, included in this volume, has been printed, and several copies stitched up separately, for the convenience of astronomers, to whom it may be useful. The volume will contain also about the same amount of planetary and extra-meridional observations as the preceding.

With regard to the reductions, they are in nearly the same state of forwardness as usual. The transits are completed to the end of 1870, and the North Polar Distances nearly so to the end of 1869, the entries and first steps of reduction of the latter being kept up pretty nearly to the present time. The Catalogue of Stars for 1869 is complete as far as concerns the Right Ascensions; and it only requires the North Polar Distances, when ready, to be written into it, to make it absolutely complete. It will contain about 1400 stars.

The times of beginning and ending of the recent Solar Eclipse were observed,— the latter very satisfactorily; and it may be worth while to mention with regard to the Heliometer, that Mr. Simms has recently made for it a solar eye-piece with polarising prisms for diminishing the light at pleasure. Up to the present time this splendid instrument has not been furnished with any apparatus for observing the Sun conveniently.

Stonyhurst College Observatory.

Several improvements have been carried out in this Observatory during the past year. The arrival of the large Spectroscope constructed by Simms, on the model of the one previously made by him for Mr. Huggins, led to the complete fitting-up of the Spectroscopic Studio adjoining the Equatoreal room. The battery required for the metal spectra is kept in the ceiled cellars

beneath the Observatory, so that the instruments may not be injured by the acid fumes, but cells of bichromate of potash are always ready in the studio for any occasional experiment. The room is also provided with spectrum maps, induction coil, spark apparatus, vacuum tubes, &c.

The old pulleys and bevel gearing have been removed from the Equatoreal shutter to make way for a rack and pinion.

The Equatoreal has been employed chiefly in the measurement of double stars and of the solar spectrum lines, and in the study of the prominences. Positions of new comets have always been obtained when the weather was favourable, and a careful watch kept for the periodic meteors.

An $8\frac{3}{4}$-inch Cassegrain mounted on a Tully altazimuth stand, and a 4-inch achromatic by Jones, were taken to Spain for the observation of the Solar Eclipse. The large Spectroscope was adapted to the Cassegrain, and the Jones Equatoreal was provided, in case of need, with a small Spectroscope, and a polarising eye-piece consisting of a Nicol and a quartz wedge.

In the Meteorological department the daily photographic records of the thermograph, barograph, and magnetographs, have been continued, as have also the curves for the velocity and direction of the wind. A new self-registering rain-guage made by Hicks from Beckley's design has just been received from the Meteorological Committee. There has been no break of continuity in the series of daily meteorological observations and of monthly determinations of the magnetic elements. The results are as usual printed for private circulation.

A paper has been presented to the Royal Society on the reduction of a seven-years' series of magnetic observations at Stonyhurst, and the second part of the French Magnetic Survey is almost ready for publication.

Royal Observatory, Edinburgh.

During the past year the daily time services by electric ball, gun-fire, and controlled clocks, have been continued as usual. Also the more laborious, and equally obligatory, work of computing the bi-diurnal observations collected from each of fifty-five town and country stations of the Scottish Meteorological Society, and sending the chief results in certified forms to be printed by the Registrar General of Births, Deaths, &c., in Scotland at the end of every month and quarter; and they have been printed accordingly.

The long kept up weekly observations of the carefully planned and very accurate series of the Edinburgh Observatory rock-thermometers, have recently been reduced to one uniform plan from their commencement in 1837, down to the end of 1869; and in that shape have been communicated to the Royal Society of London. A discussion of certain supra-annual cycles of tem-

perature in the Earth's surface crust, thus arrived at, accompanied the MS. figures; together with a forecast founded upon them, of the temperature characteristics to be, of the present season ;— the date of communication of that forecast having been the beginning of last March.

Excepting only a few instances, the usual meridian observations of stars for place, with the transit instrument and mural circle, have been discontinued for a time; partly, because there has been only one assistant in the Observatory during a large portion of the year; and partly, in order to allow of the computation of past observations in right ascension and north polar distance being more speedily overtaken.

A Report of 34 pages with several plates (intended to appear also in the 13th volume of the *Edinburgh Astronomical Observations* now commencing at the press), addressed to the Government Board of Visitors, has been printed by the Astronomer during the past summer, and generally circulated. It contains, amongst other Observatory topics, an inquiry into the fluctuations of the position of the transit instrument on the Calton Hill, during the last twenty-nine years, and traces them up, both astronomically and experimentally, at last, it is believed, to their true source, viz., the untoward *physical* nature, touching thermotic effects, of the particular kind of stone of which the said piers are constructed; and an inquiry is therefore now much desired to be commenced into the degrees of suitability of different materials for the most exacting of the astronomical requirements of a first-class Meridian Observatory.

Glasgow Observatory.

The operations at the Glasgow Observatory continue as heretofore to be devoted chiefly to a course of star-observations, the objects selected for this purpose generally ranging between the sixth and ninth magnitudes. Some observations of the minor planets have also been made with the transit-circle during the past year, and the results are now being prepared for publication in the *Astronomische Nachrichten.*

Greenwich Mean Time has been transmitted electrically as in past years to the City and Port of Glasgow. Increased facilities have recently been given for the rating of chronometers, and the admirable advantages of Jones's invention are now appreciated by all classes of the community.

Since the beginning of the year 1868 a system of meteorological observations executed with self-registering instruments has been in operation at the Glasgow Observatory. The observations are conducted at the public expense under the superintendence of the Meteorological Committee of the Royal Society. The results of the observations are transmitted weekly to Kew, whence they are forwarded to the Central Office of the Committee in London. During the past year a Quarterly Weather Report has been pub-

lished under the superintendence of the Committee, including, among other matters of interest, a graphical delineation of the results obtained with the various self-recording instruments at the seven affiliated observatories.

Kew Observatory.

The Photoheliograph has been worked under the direction of Mr. De La Rue during the past year, the ninth of the continuous photographic observations of the Sun. From Jan. 1 to Dec. 31, 1870, 380 pictures were obtained on 220 days. During the eclipse of Dec. 22 only five pictures could be made in consequence of the unfavourable state of the weather; the heliographic positions of the Sun-spots for that day have been determined from some of the Sun pictures, and will be communicated to the Society. By means of a grant of money made by the Royal Society for that object, six sets of positive prints have been struck off for distribution from the whole series of negatives obtained during the nine years the heliograph has been at work, and completed up to date. In 1869 Messrs. De La Rue, Stewart, and Loewy presented a paper to the Royal Society (*Phil. Trans.* vol. clix. p. 1), containing a full description of the method adopted by them for ascertaining the position and areas of Sun-spots, and tables giving the areas and positions for the various Sun-spots observed during the years 1862–3 at Kew. A paper read before the Royal Society on March 10, 1870, and just published, contains the same elements for 1864–5–6; it also contains a discussion of Hofrath Schwabe's (of Dessau) collection of drawings of the solar disk from the time of their commencement in 1825 to that of their termination in 1867. The Kew heliograph will be worked until December 1871 by means of a sum voted from the Government grant of the Royal Society, when, unless some steps are taken to carry on the observations, systematic Sun-work will be discontinued in England.

Mr. Huggins' Observatory.

During the past year the Observatory has been rebuilt, and a drum of 18 feet diameter erected in place of the former dome of 12 feet diameter, to fit it to receive the large equatorial instrument constructed by Messrs. Grubb and Son for the Royal Society, and by that Society placed in the hands of Mr. Huggins.

This instrument is provided with a tube and object-glass 15 inches in diameter, and a tube fitted with a speculum of 18 inches diameter, either of which can be attached at pleasure to the declination axis of the equatorial mounting. The focal length of the object-glass, the lenses of which are united with castor-oil, is 15 feet. This instrument performs admirably in all respects and does great credit to the makers.

Spectroscopes specially adapted for the instrument and suitable

for the observation of the stars, nebulæ, and Sun, have been constructed by Messrs. Grubb and Son on the very admirable plan of automatic motion for minimum deviation recently described by them in the *Monthly Notices*.

There has not been time, as yet, to do more than make the preliminary observations for the adjustments of the instrument.

Notes on some Points connected with the Progress of Astronomy during the Past Year.

General Remarks.

The progress of Astronomy, in common with that of every other science, has been affected by the terrible war, which has so largely absorbed the attention of all classes since July, 1870. We have been influenced by it in England, but in France and Germany scientific progress has been greatly interrupted. Even before the completion, in September last, of the great cordon of troops and artillery which shut off Paris from the rest of the world, the effects of war on science were shown by the reduced size of the *Comptes Rendus*, and the disappearance of some French scientific journals. In Germany, many young astronomers of great promise, not altogether unknown in this country, exchanged the observatory for the battle-field, where some, alas! have fallen.

But notwithstanding these unfavourable circumstances, the year just closed has not been barren of discoveries. Three planets, hitherto unrecognised, have been added to the known members of the solar system; four comets have been detected, some even in Germany by an observer at no great distance from the scene of war; and an increase of our knowledge of the constitution of the Sun has been undoubtedly obtained from the recent Solar Eclipse, to observe which, two of the greatest astronomical expeditions of modern times were organised and despatched from this country and America to Sicily, Cadiz, Gibraltar, and Oran. In our own Society the evening meetings have been well attended, at which important papers — of which a list will be found on another page — have been read and freely discussed.

The Total Solar Eclipse, Dec. 22, 1870.

As this eclipse would be total at several places within easy reach of England, namely, the south of Spain, Sicily, and the north coast of Africa, it appeared to the Council an occasion on which they should take steps to assist observers, and, if necessary, organise an expedition provided with suitable instruments for attacking the important problem which still remained unsolved,

—the extent and nature of the Coronal Light. At the meeting of Council held in March, the Council resolved itself into a committee to consider the preparations to be made for the observation of the Solar Eclipse of Dec. 22. In the following month this committee united itself with a committee appointed for a similar purpose by the Royal Society. At a meeting held by this joint committee on June 16 it was resolved that the Government be solicited to grant two ships for conveyance of observers to Spain and Sicily, and also a sum of money for the preparation and transport of instruments. To this application, which was made in accordance with former usage, to the Admiralty, an unfavourable answer was received on August 10. Absence from town of some members of the joint committee and other circumstances prevented any further steps being taken until November 4, when the joint committee met and resolved that an application for means of transit for the expedition and for a pecuniary grant in aid of the funds voted by the Royal and Royal Astronomical Societies should be made to the Lords Commissioners of Her Majesty's Treasury. To this renewed application a favourable reply was returned by the Government, who placed H.M. Troop-Ship "Urgent," at the service of the expedition for the conveyance of observers and instruments to Spain and Africa, and the sum of 2000*l.* in aid of the travelling expenses of the overland party to Sicily and for the preparation and transport of instruments.

At this late moment, a few weeks only before the expedition should leave England, the greatest energy was needed to organise a party of observers and procure the special instruments needed for the proposed observations. A small organising committee was appointed, which met almost daily up to the departure of the expedition. The successful and very complete arrangements ultimately made were due in great measure to the unflagging zeal of the secretary Mr. Lockyer and of the assistant-secretary Mr. Ranyard; and the Council wish here to state how much in their opinion is owing to the valuable suggestions and assistance afforded by Prof. Stokes. The opticians, Mr. Browning, Mr. Grubb, Mr. Ladd, and Mr. Slater, afforded very valuable assistance to the expedition by the preparation and loan of instruments, for which they deserve the grateful thanks of the Society.

Distinct observing parties in charge of Mr. Lockyer, Rev. S. J. Perry, Capt. Parsons, and Mr. Huggins, were appointed for the four stations, Sicily, Cadiz, Gibraltar, and Oran. Professor Tyndall accompanied the Oran party as an independent observer.

Lord Lindsay, taking with him several skilled observers and a very complete photographic apparatus, went to Cadiz independently at his own expense.

Besides these English expeditions there was an American expedition, with Prof. Peirce at its head, consisting of two parties, one in Sicily, under Prof. Peirce himself, and one in Spain, under Prof. Winlock. Independent observations were

taken by Prof. Newcomb at Gibraltar, and by a party consisting of Profs. Hall, Eastman, and Harkness, in Sicily.

At no former eclipse have preparations been made on so complete a scale, or the work to be done so skilfully divided among observers trained to carry out efficiently the parts assigned to them. All the parties were prepared to attack the corona by the several methods of the spectroscope, the polariscope, photography, and eye-drawings. With favourable weather it was not too much to expect from these expeditions a searching and almost exhaustive examination of the coronal light by these different methods of attack.

The weather was not propitious; at all the stations the sky was more or less obscured by clouds. On the African continent, where there had been grounds for confidently anticipating a cloudless sky, the English party and M. Janssen, who had escaped with his instruments from Paris in a balloon, at Oran, and Drs. Weiss and Oppolzer at Tunis, saw nothing of the eclipse at the time of totality, though the earlier phases were visible at Oran.

At Cadiz and in Sicily successful photographs of the totality were obtained by Lord Lindsay, Mr. Willard, of the American Expedition, and Mr. Brothers. At these stations, and also at Estepona, some observations were obtained of the spectrum and polarization of the corona.

Although the gain to our knowledge of Solar physics is much less full and decided than doubtless it would have been if the very efficiently equipped and competent observers had been favoured with a cloudless sky, the new information which comes to us from the eclipse is very valuable, and well repays the large amount of thought, time, and money, which were so freely bestowed upon the preparations.

The present time is too early for a complete analysis of the different observations with a view of eliciting from them the new teaching which they may contain of the extent and nature of the coronal light, still it may not be undesirable to give a short account of some of the more important observations.

In the last Annual Report, in the account of the Eclipse of August, 1869, attention was called to the two apparently distinct portions besides the prominences in the light seen round the Moon during totality. The American pictures showed similar indications of brighter portions near the Sun's limb, within which the eruptions of hydrogen forming the prominences take place, to those which were visible in the photographs taken by Mr. De La Rue in 1860, and by Major Tennant and Dr. Vogel in 1868. A distinction between different portions of the coronal light was observed as early as 1706 by MM. Plantade and Capiés at Montpelier. "As soon as the Sun was eclipsed there appeared around the Moon a very white light forming a corona, the breadth of which was equal to about 3′. Within these limits the light was everywhere equally vivid, but beyond the exterior contour it was less intense and was seen to fade off gradually into the surrounding darkness, forming

an annulus around the Moon of about 8′ in diameter." In 1842 M. Arago considered this distinction to be sufficiently marked to sanction the subdivision of the corona into two concentric zones, the inner zone equally bright and well defined at the outer border, while the exterior zone gradually diminished in brightness until it was lost in the surrounding darkness.

The observations of the eclipse of last December confirm these earlier descriptions as to the apparent subdivision of the coronal light, though the breadth of the inner zone varies considerably as described by different observers. In our future remarks we shall restrict the word *corona* to the inner brighter ring, and for the faint exterior portion use the term *halo*.

It may conduce to clearness in our interpretation of those observations which appear to differ from each other, if we consider that the imperfect transparency of our atmosphere must cause a scattering of a portion of the light of the corona seen through it, and form a more or less brightly illuminated screen between the eye and the eclipsed Sun. This atmospheric light will interfere especially with the observer's appreciation of the form and extent of the faint halo. There may exist at least three distinct sources of the light seen about the Sun, in addition to the prominences, the corona, a solar halo overlapping the corona or beginning at its exterior limit, and an atmospheric halo produced by the scattering of the light by our atmosphere. The corona and solar halo would probably not alter greatly in the short time between observations of the same eclipse at different stations, but the scattering of light would be peculiar to each station, and be mixed up with the effect of haze or light cloud present at the time. It is *possible* that without the Earth's atmosphere, some scattering of light may arise from the imperfect transparency of interplanetary space, not to speak of the possible existence of finely divided matter more densely aggregated in the neighbourhood of the Sun. It may be that in these and some other considerations will be found the key to the interpretation of the widely different descriptions of the solar surroundings which come to us from different observers.

Prof. Watson observing at Carlentini describes a bright corona about 5′ high, observations at Cadiz give a breadth of about 3′; Lieut. Brown observing with Lord Lindsay found the inner zone which he saw defined at its outer margin to vary from 2′ to 5′ in breadth. Mr. Abbatt at Gibraltar at about 5′ high. Some of the observers describe the exterior contour of the corona to be affected by the prominences bulging out over the loftiest of these. In the photographs a defined zone is also seen,—in Lord Lindsay's photographs and the one taken by Mr. Willard, it extends rather more than 1′. In the photograph by Mr. Brothers the height of the brighter zone varies from 3′ to 5′.

We will now speak of the photographs of the totality, which are very instructive.

The photographs taken at Cadiz by Lord Lindsay were ob-

tained by placing the sensitive surface at the focus of a silvered glass mirror 12¼ inches in diameter and 6 feet focal length, giving an image of the Sun about ¾-inch in diameter. The other photograph taken near Cadiz by Mr. Willard of the American expedition, was obtained at the focus of an achromatic object-glass of 6 inches diameter, specially corrected for actinic rays.

Mr. Brothers, at Syracuse, employed a photographic object-glass of 30-inches focal length and 4 inches diameter, lent to him by the maker, Mr. Dallmeyer.* This lens gave a brilliant image of the Sun about three-tenths of an inch in diameter, which was received upon a plate 5 inches square. The camera was mounted on the Sheepshanks equatoreal, belonging to the Society.

The photograph taken at the commencement of totality by Lord Lindsay had an exposure of twenty seconds. It shows around the Moon's advancing limb a bright corona extending about 1′ from the Moon's limb, in which the prominences are distinctly marked, and outside this a halo of faint light diminishing rapidly in brilliancy with indications of a radial structure which can be traced as far as 15′ from the Moon's limb. On the other side of the Moon, where it overlaps the Sun sufficiently to conceal the prominences and the bright corona, *the halo is almost absent.* It may be suggested that such portion of the halo as appears around the advancing limb of the Moon has its origin on this side of the Moon. As a pure speculation the explanation may perhaps be hazarded, that the true solar halo, as some spectroscopic observations would suggest, was less powerfully actinic than the scattered light of the prominences and corona, in which the halo on the one side of the Moon only as seen on the plate may have its origin.

The photograph taken by Mr. Willard was exposed during a minute and a half, and therefore must contain mixed up several successive appearances. The prominences are distinctly shown, and a defined corona of rather more than 1′ in height. In the halo there are indications of portions of unequal brightness, and a radial structure, but the most remarkable feature is a V-shaped rift or dark space in the halo on the south-east, beginning from the outer boundary of the bright corona, a second similar dark space is faintly traceable on the south. The same dark gaps are also recorded in an eye-sketch by Lieut. Brown. Similar dark rifts are also shown in Mr. Brothers' photograph taken at Syracuse. The photograph taken by Mr. Brothers is very valuable, since it shows the halo extending towards the north-west, about two diameters of the Moon, and on the east and south about one diameter, the halo, therefore, is not concentric with either the Sun or Moon, but extends to the greatest distance in the direction from which the Moon is moving. It shows in many parts traces of a radial structure. The stronger light about the Moon is much broader on the west and north-west, and assumes a somewhat stellate

* These lenses are constructed by Mr. Dallmeyer for photographic copying.

appearance with rays gradually softening down as if combed out into the fainter halo. This photograph was taken in eight seconds, from the 93rd to the 101st second after the commencement of totality, and therefore presents a true representation of the different phenomena at the time, that is, as regards their relative actinic power which may possibly differ in a sensible degree from the relative brightness they present to the eye. The eye-sketches made at different stations show remarkable differences, especially in the form of the outer part of the halo; some represent it as consisting of separate rays, others give to it an almost true geometrical contour; in some of the Spanish sketches a tendency to assume a roughly quadrangular form can be detected, while in most of the Sicilian drawings there is a tendency to an annular form.

We pass to the spectroscopic observations of the corona and halo.

Prof. Winlock, using a spectroscope of two prisms on a five and a half inch achromatic, found a faint continuous spectrum. Of the bright lines, the most persistent was 1474 Kirchhoff. This bright line, and the continuous spectrum without dark lines, were followed from the Sun to at least 20′ from his disk. Prof. Young estimates the least extension of this line to a solar radius.

Capt. Maclear, observing with a direct vision spectroscope attached to a four-inch telescope, saw a faint continuous spectrum and bright lines in positions about C D E and F to a distance of 8′ from the Moon's limb, and also the same lines, but much fainter, *on the Moon's disk.* This observation would seem to show, as has been already suggested, that some of the light from the true surroundings of the Sun is scattered by some medium between the eye and the Moon, and therefore the distance from the Moon to which these lines can be traced does not imply necessarily an equally great extension of the true halo.

Lieut. Brown, of Lord Lindsay's party, saw only a continuous spectrum without bright lines, from $4\frac{1}{2}'$ to 25′ from the Moon's limb. Mr. Carpmael, observing at Estepona, saw three bright lines in the spectrum of the corona. He considers the one in the green to correspond with 1359 Kirchhoff.

The observations with the polariscope show that a portion of the coronal light is polarized; and though the results as to the plane of polarization are interpreted differently by different observers, there seems reason to suppose with Mr. Ranyard and Mr. Peirce that the light is polarized radially, showing that the corona and halo may possibly reflect solar light as well as emit light of their own.

There is one observation made by Prof. Young which is of so much importance that it will be well to give an account of it in Prof. Langley's words:—

"With the slit of his spectroscope placed longitudinally at the moment of obscuration, and for one or two seconds later, the field of the instrument was filled with bright lines. As far as could be judged, during this brief interval every non-atmospheric line

of the solar spectrum showed bright; an interesting observation confirmed by Mr. Pye, a young gentleman whose voluntary aid proved of much service. From the concurrence of these independent observations we seem to be justified in assuming the probable existence of an envelope surrounding the photosphere, and beneath the chromosphere, usually so called, whose thickness must be limited to two or three seconds of arc, and which gives a discontinuous spectrum consisting of all, or nearly all, the Fraunhofer lines showing them, that is, *bright* on a dark ground."

Rapid and imperfect as this early sketch must necessarily be of the observations of the last eclipse, it shows a distinct and important gain to our knowledge of solar physics.

Spectrum Analysis.

In the winter of 1867–8 Angström found the light of the auroral arch to be nearly monochromatic, giving in its spectrum a single brilliant line in the green near the group of calcium lines, and traces of three feeble bands near F. This observation was confirmed by Struve in 1868. In 1869, Prof. Winlock observed five bright lines in the green and blue parts of the auroral spectrum.

During the past year a brilliant line in the red portion of the spectrum has been detected in some parts of the auroral display. This line was observed first by Mr. Ellery at Melbourne, on April 5, 1870. "The red streamers," he writes, "were gorgeous, and emitted light enough to read a newspaper by. The most remarkable and brightest of the lines in the spectrum was a red line more refrangible than C; a greenish band or two in the position of the green calcium lines, and a cloudy band more refrangible, appeared as if irresolvable into lines. The dark segment rested on the sea-horizon. Above this was an arch of greenish auroral light, and from a well-defined boundary of this the rose-coloured streamers started zenithwards. The red line disappeared immediately the spectroscope was directed to any point below this boundary, and only the green lines remained. The loss and reappearance of the red line was as sharp as possible as the slit passed from the red to the green region."

On October 25 Zöllner compared the position of the red line with the lines of lithium and sodium. From the position of the auroral line relatively to these, he considers that it falls in the spectrum very nearly where a group of atmospheric lines occurs in the solar spectrum having a mean wave-length of 0·0006279. Zöllner suggests that this auroral spectrum, which does not correspond with any known spectrum of the gases of the atmosphere, may be a spectrum of one or more of these gases of an order we have not yet been able to obtain experimentally, since we can have to do only with thin strata of gas, whereas the auroral light may come from an enormously thick layer of one or more of the gases of the atmosphere at a relatively low temperature.

Our Fellow, Mr. Lockyer, in continuation of his important researches on Solar Physics, considers that he has now evidence, from the different behaviour of the line C and the line near D, that the latter does not belong to hydrogen—a result in harmony with the absence of the line near D, from the different spectra of hydrogen obtained experimentally.

His observations show, he believes, that prominences may be divided into two classes,—those in which great action is going on and lower vapours injected, and those which are tranquil so far as wave-length goes, which are usually high, bright, and persistent.

While observing a solar spot with the spectroscope, on April 16, Mr. Lockyer saw "the whole prominence spectrum was built up of single discharges shot out from the region near the limb, with a velocity sometimes amounting to a hundred miles in a second. On the following day, using a tangential slit, he found "in the spectrum of the base of the prominence hundreds of the Fraunhofer lines beautifully bright." Mr. Lockyer considers that he has evidence that at the present maximum period of sun-spots not only is the region of a spot comprised by the penumbra, but the chromosphere also is shallower than in the year 1868.

Prof. C. A. Young has succeeded, by means of a spectroscope having a dispersive power of thirteen prisms of heavy flint each with an angle of 55°, attached to an achromatic telescope of 6·4-inches aperture, and 9 feet focal length, in obtaining photographs of the solar prominences. Negatives have been made which show clearly the presence and general form of the protuberances, but at present the definition of details is unsatisfactory. The hydrogen line γ (2796 of Kirchhoff), though very faint to the eye, was found to be decidedly superior to F in actinic power.

On Sept. 14, Prof. Young saw a very brilliant small fragment detach itself from a prominence, enlarging in size, and growing fainter as it rose. It disappeared in 12½ minutes at a distance of 2′ 30″ above the limb of the Sun. Allowing for the obliquity of motion to the parallel of declination, the length of path passed over by this cloud was more than 90,000 miles, with a velocity of above 120 miles per second.

Prof. Young observed on Sept. 27 a prominence formed of separate, well-defined narrow streamers, which appeared to consist of matter first violently ejected and then as violently deflected by some force acting nearly at right angles. He says:—"I am unable to see how any mere projection from the Sun could have produced such a form, and cannot help feeling that it indicates a something in which powerful currents may exist, even at such great elevations above the solar surface. In short, an atmosphere extending far beyond the limits which calculation would seem to assign as possible."

Prof. Young calls special attention "to a bright line 2581·5, Kirchhoff, the only one of my list which is not given on Mr. Lockyer's. This line, which was conspicuous at the eclipse, 1869, seems to be always present in the spectrum of the chromosphere,

and shows the form of its upper surface or of a protuberance nearly as well, though, of course, not so brightly as the line 2796. It has no corresponding dark line in the ordinary solar spectrum, and not improbably may be due to the same substance that produces D."

Professor Respighi has done good service in the same field of research by mapping all the prominences which appear around the Sun from day to day, and arranging them for each day in a straight line, so that the appearances for different days by being placed under each other admit of easy comparison. From the conclusions to which this method of studying the forms of the prominences has led him, we may select one or two. "The prominences are less active, less frequent, and less developed at the equator than towards the poles, while in the circumpolar regions great protuberances are not met with, but only very small, temporary flames,—the prominences seem to be, therefore, in connexion with the spot-zones, and possibly to be influenced by the solar rotation." "The difference of duration of the prominences is very great, while some develope and disappear in a few minutes, others remain visible for many days."

Mr. J. H. Hennessy, to whom a spectroscope was intrusted by the Royal Society for observations of the atmospheric lines of the Solar Spectrum at different altitudes of the Sun at the favourable position of Mussoorie, has sent in a first report of his observations, together with a chart of the atmospheric lines, as seen by him at sunset. This map has been printed in the *Proceedings of the Royal Society*, and may be found of assistance to those who are studying these lines.

Valuable additions have been made during the past year to the apparatus employed in spectroscopic research. The most important of these doubtless are improved methods by which the prisms of a spectroscope can be brought automatically to the position of minimum duration for any part of the spectrum to which the observing telescope is directed. By such an arrangement the spectrum is rendered more nearly normal with respect to the relative extension of the different colours, but the most important advantage is the greater brightness of the spectrum, precisely where light is most needed, towards the violet and red limits of the visible spectrum, in consequence of the whole of the light from the collimator being enabled to reach the observing telescope. Instruments possessing these advantages in a greater or less degree had been constructed by Littrow, Rutherford, Prof. Young, and Mr. Lockyer. We must refer to the *Monthly Notices* for a description of independent methods by which this important addition to the spectroscope has been successfully accomplished by Mr. Browning and Mr. Grubb, and for the valuable suggestions contained in a paper by Mr. Proctor.

Attention may also be called to new forms of registering spectroscopes constructed for recording rapidly the positions of lines which might be seen during observations of the late solar eclipse. Professor Winlock contrived a form of instrument in which the positions of the observing telescope when directed to different parts of the spectrum are recorded by marks upon a plate of silvered copper.

In an instrument constructed by Mr. Grubb at the suggestion of Mr. Huggins, the observing telescope is fixed, and a pointer placed at its focus can be brought rapidly to any part of the spectrum by a quick motion screw, a positive eye-piece being used, which is movable, so that the line under observation can be brought into the middle of the field. The arm carrying the pointer is connected by a lever with a second arm carrying two needles, which pass over a card contained in a frame, which may be brought successively into five new positions, for the record of as many spectra. By pressing a finger on one of the needles, a prick on the card records the position of the line. If the line is bright, the second needle is also pressed, by which a second prick is made below the one recording the position of the line, and in this way a bright line is distinguished from dark lines which may have been recorded.

The Minor Planets.

Three minor planets have been discovered within the last twelve months, *Lydia* (110) at Marseilles, by M. Borelly, on April 19; *Ate* (111) at Hamilton College, Clinton, New York, by Dr. C. H. F. Peters, on August 14; and *Iphigenia* (112) also by Dr. C. H. F. Peters, on September 19. The mean distance of each from the Sun, assuming the radius of the Earth's orbit = 1, is for *Lydia* 2·693, *Ate* 2·576, and *Iphigenia* 2·436. The three new members are therefore included among those composing the innermost portion of the asteroidal ring between *Mars* and *Jupiter*. The mean distance of *Flora*, the nearest of the minor planets, is 2·201, and that of *Sylvia*, the most distant, is 3·494.

The *Berliner Jahrbuch* for 1873 contains a supplement giving approximate ephemerides for 1871, at 20-day intervals, for 108 of the minor planets. The places are sufficiently accurate for finding them with the equatoreal. Daily ephemerides for 58 are also given when the planets are near opposition. As astronomers have now to rely, with few exceptions, on the *Berliner Jahrbuch* for the tabular places of the minor planets, it would be very advantageous to meridional observers if errors of the ephemerides were published in the *Monthly Notices* or the *Astronomische Nachrichten* as soon as possible after equatoreal observations have been made. The identification of the smallest of these minute objects is always a matter of difficulty when observed in a telescope with a field full of objects of a similar magnitude.

The minor planets continue to be systematically observed at

Greenwich, Paris, Königsberg, Leipzig, Leyden, Washington, the Observatory of Hamilton College, Clinton, New York, and a few others. Since the closing of Paris by the siege, they have been observed at Greenwich throughout the lunation when practicable, instead of only during the period from new to full Moon. The very cloudy weather of the last few months has, however, very seriously interfered with this class of observations.

Recent numbers of the *Astronomische Nachrichten* contain detailed investigations of the orbits of *Thalia*, *Polyhymnia*, and *Euphrosyne*, by Mr. Schubert, of the American Nautical Almanac Office, to whom Astronomy is already indebted for many similar researches. M. Oppolzer has also contributed a paper on the Orbit of *Olympia* (*Elpis*), in which he has availed himself of all the observations of that planet made since its discovery in 1860.

Discovery of Comets.

The following comets have been under observation since the date of the last Report. Three of them were detected by our Associate, Dr. Winnecke, whom the Council are glad to see restored to active work after his long illness.

1. Comet I. 1870, discovered by Dr. Winnecke, at Carlsruhe, in May 29.
2. Comet II. 1870, discovered by M. Coggia, at Marseilles, on August 28.
3. Comet III. 1870 (Periodic Comet of D'Arrest), detected by Dr. Winnecke, on August 31.
4. Comet IV. 1870, discovered by Dr. Winnecke, on November 23.

All these comets have been well observed, especially at the German observatories. The elements of their orbits, as well as the separate observations, have been published in the *Astronomische Nachrichten*. Some observations of Comet II. 1870, by Mr. Joynson, are inserted in the *Monthly Notices* for December.

The New Zenith Sector of the Indian Survey.

The zenith sector constructed by Messrs. Troughton and Simms from the designs of Colonel Strange, alluded to in the last Annual Report as having been forwarded to India, has been practically tested by observations of stars in the ordinary routine work of the Indian Great Trigonometrical Survey. After the scrupulous attention given by Colonel Strange to every detail required in the construction of the instrument, some of which were of a novel character, it must be very gratifying to him and also to those who inspected the sector before it left England, to find that the promise of good work given by the preliminary trials at the observatory of the Indian Store Department, has been fulfilled to the satisfaction of the observer, Captain Herschel, by whom the observations in India have been made. As an

illustration of the general accuracy of the determinations of absolute latitudes by the use of the new zenith sector, Captain Herschel remarks that one night's observation (of thirty-six stars in six hours) is amply sufficient to give a resulting latitude, of which the probable error is not greater than $0''{\cdot}2$. Referring to a recent determination described in a communication to Colonel Strange, he further remarks that "at the last station twenty-two stars out of the list were *Nautical Almanac* stars, so that the latitude was easily deducible. Cutting out *Procyon*, which has a large proper motion, and, I suspect, an erroneous place; and *γ' Virginis*, which has almost certainly an erroneous place, due to confusion of the two components, the remaining twenty give latitudes all falling within a range of $1''{\cdot}6$." Captain Herschel is of opinion that this satisfactory agreement is due entirely to the great stability of the instrument, and not to any unusual skill on the part of the observer. The Council have great pleasure in congratulating Colonel Strange on the success attending the active employment of this the first of the two proposed zenith sectors to be furnished for the use of the Indian Survey, the construction and examination of which occupied his attention for a considerable time. There seems but little doubt that in their new zenith sector, the officers of the Indian Survey possess a sensibly perfect field instrument for the determination of terrestrial latitudes, and for other geodetical purposes.

The Graphical Construction of a Solar Eclipse.

Among the many valuable astro-mathematical investigations for which the Society is indebted to Prof. Cayley, that on the Graphical Construction of a Solar Eclipse is not the least important. In addition to a complete theoretical discussion, explaining every detail connected with the subject, an example is appended to show that the method can be adapted to practical use. Prof. Cayley has chosen for his example the eclipse of the Sun of December 21–22, 1870. Taking the times and places of the beginning and end of the eclipse, it appears that the error from his construction amounts only to $1\frac{1}{2}$ minute of time and about $1\frac{1}{2}$ degree of place. Prof. Cayley, however, considers that a far greater accuracy than this might be obtained, if a more complete blank projection had been employed by him, and more care taken consequently in the construction. If this were done, then there is but little doubt that a diagram of an eclipse could be constructed which would bear a favourable comparison with the diagrams inserted in the eclipse section of the *Nautical Almanac*.

Mr. Proctor's New Star-Atlas.

For the use of an astronomical instrument a star-catalogue is absolutely necessary; but when an acquaintance with the

separate constellations, or with the general configuration of the principal stars is desired, recourse must be had either to a globe or to a good star-atlas. The valuable star-charts which have been published within the last thirty years, such as those of Argelander, Chacornac, Dien, the Berlin maps, and Mr. Bishop's charts, are useful only to the astronomer who is in the habit of comparing for special purposes the small stars in the field of his telescope with their recorded positions in the chart. These representations of the heavens include stars down to the ninth magnitude, while in special districts of limited extent stars no brighter than the minor planets have been entered. For reference to the relative positions of the brighter stars, however, these charts help us little; and it was to supply this want that our indefatigable Fellow, Mr. Proctor, published in a series of twelve maps a representation of the heavens arranged in such a manner as to exhibit, without sensible distortion of the constellations, all the stars contained in the British Association Catalogue, all the nebulæ in Sir John Herschel's catalogue down to the order marked very bright, all the binaries and suspected binaries in Mr. Brothers' catalogue; all the objects in Admiral Smyth's Celestial Cycle; all the red stars contained in Dr. Schjellerup's catalogue; and, finally, all the recognised variable stars. Two index-plates are also given in which the constellation-figures are inserted.

The maps were drawn originally on the scale of a 30-inch globe, and subsequently reduced by Mr. Brothers, of Manchester, by photo-lithography. Although there is a want of that finish which a professional lithographer would probably have given to the lines and writing, yet that is of small moment in comparison with the preservation of accuracy obtained by the use of photography. The maps are, therefore, exact copies, on a reduced scale, of Mr. Proctor's work as performed by his own hand. The work is dedicated to the memory of our late esteemed President, Admiral Manners.

The Orbit of α Centauri.

The brilliant binary of the southern hemisphere, *α Centauri*, has occupied the attention of observers, at intervals, from the date of Feuillée's observation at Lima, in July 4, 1709, to the present time, either in observations for the investigation of its annual parallax, or for the determination of the elements of its orbit. Recently Mr. E. B. Powell, of Madras, has published revised elements of the orbit of *α Centauri*, determined from a series of recent observations made by himself at a favourable part of the stellar orbit, when the extremity of the perspective ellipse corresponded to the lesser maximum of distance. Mr. Powell is so well satisfied with his observations and deductions as to remark: — 'Now, however, though even four or five additional years will enable us to improve the orbit, especially as to the time of periastral passage, the results I have arrived at undoubtedly approxi-

mate *pretty closely* to the truth." From one hundred observations on thirteen nights the angle of position for the epoch 1870·1 was found to be 20°·27′, and from 162 observations on twelve nights, the angular distance equalled 10″·24. The computed period of revolution is 76·25 years. It is the intention of Mr. Powell to lay the complete details of these observations before the Society in a future paper.

Distribution and Distances of the Fixed Stars.

There is no section of astronomical speculation more fascinating than that relating to the probable laws which have governed the distribution and relative distances of the stars. The late Professor Struve, in his remarkable and classical treatise *Etudes d'Astronomie Stellaire*, put forward a general theory founded upon an investigation of the stars observed by Bessel in zones, and catalogued by M. Weiss. The general conclusions of M. Struve were accepted by the principal astronomers as a theory reasonable and probable, although the application of his theory was necessarily liable to some irregularities. So great was the approval of M. Struve's speculations on the relative distances of the stars, which were classified by him into groups, according to magnitude,—stars of the first magnitude being the first group and the nearest to our solar system,—that his results were adopted in many subsequent stellar investigations, especially by the Astronomer Royal, in his first paper on the "Movement of the Solar System in Space," and also in the second, which was written at his request by Mr. Dunkin.

Since the publication of the theoretical conclusions of the two Herschels and Professor Struve, the subject has remained somewhat in abeyance till Mr. Proctor, during the construction of some of his star-maps, was impressed with certain apparent laws of stellar distribution and aggregations, presented by the stars visible to the naked eye. He believes that if a systematic study of the general distribution of the smaller stars were made, still more remarkable laws of aggregation would be probably revealed. For example, if the 310,000 stars contained in Argelander's charts were mapped upon the interior surface of a hollow globe, together with all the known nebulæ, the results of Herschel's star-gauges, and an accurate representation of the Milky Way and Magellanic Clouds, a larger amount of light would be thrown on the relations between the members of the sidereal system than could be obtained by direct observation, even with the most powerful instruments.

Among the numerous papers read before the Society during the last year by Mr. Proctor, two on this subject may be referred to. The first is entitled, "On the Resolvability of Star-Groups, regarded as a test of Distance;" and the second, "The Laws according to which the Stars visible to the naked eye are distributed over the Heavens." In the first of these papers,

Mr. Proctor expresses an opinion that the mere clustering aggregation of unresolved stars is no evidence that the cluster is at a relatively immense distance. He supposes such a cluster to consist of a number of stars all equal in magnitude, and separated from each other by equal intervals, so that each star could be recognised. If the cluster were rapidly swept away into space, the distances between the stars would become smaller as the group gradually disappeared. If the intervals became too small to be distinguished, and the stars remained visible, the result would be a nebulosity. But, on the contrary, if the distances between the stars were sufficiently great to permit each to be seen separately at the moment of disappearance, then the cluster could never become nebulous. Mr. Proctor, therefore, remarks, "that the nebulosity of a star-group whose members are equal and equally distributed, is a question not of distance merely, but of constitution, of the relation between the size and brightness of the constituent orbs and the distances which separate them from each other."

The second paper discusses the relative distribution of the visible stars over the heavens. Mr. Proctor has divided the celestial sphere into areas of different dimensions, the largest being $\frac{6}{11}$ of the area of the hemisphere, and the smaller $\frac{1}{62}$ part, the latter being the gaps or lacunæ in the Milky Way. A very rich region of lucid stars covers *Cygnus*, *Cepheus*, *Ursa Minor*, and *Lacerta*, in the northern hemisphere, while a corresponding rich region covers the keel of *Argo Navis* in the southern hemisphere. But the richest region to be found in both hemispheres is the Milky Way. From a consideration of the comparative number of lucid stars contained in each of the thirteen regions into which Mr. Proctor has divided the heavens, he shows that among the lucid stars special laws of aggregation and segregation exist; and as the lacunæ in the Milky Way are exceptionally bare, while the Milky Way itself includes the richest region of lucid stars, "the fact seems," says Mr. Proctor, "to dispose beyond all question of the theory that the stars forming the milky light of the galaxy (regarded as a whole) lie at vast distances beyond these lucid stars."

Although the Council are not at present in a position to offer any opinion on the stellar speculations which Mr. Proctor has brought before the Society, yet they acknowledge the originality of thought which has been exhibited in these and other papers by him on the probable constitution of the universe.

Dunsink Observations.

During the past year the Astronomer Royal for Ireland has published a report of his observations from 1868 to 1869 with the South refractor. The object-glass of this instrument, $11\frac{1}{4}$ inches diameter, was the gift of the late Sir James South. The

lens was mounted equatorially by Messrs. Grubb and Son in in a very convenient observatory in 1868. The first paper in Dr. Brünnow's report contains a new investigation of the parallax of α *Lyræ*. This investigation rests upon a number of observations of the distance and angle of position of the small companion, the parallax obtained represents therefore the difference of the parallax of the two stars; but as the small star does not participate in the proper motion of α *Lyræ*, Dr. Brünnow considers that its parallax, if it could be taken into account, probably would not alter the parallax assigned to the large star by one hundredth of a second. The value of π comes out $+0''.2143$ with a probable error of $\pm 0''.0095$. Dr. Brünnow intends to check this result by the method of observing differences of declination.

The second investigation consists of the determination of the parallax of 61 σ *Draconis* from comparison with a star of the tenth magnitude which is situated 1′ north, and follows it at $1^m\ 52^s$. The result comes out $\pi = +0''.225$ with a probable error of $\pm 0''.0279$. As this value is derived from comparison with only one star, it is possible, though by no means likely, that the periodical variation of the observed differences of declination may not be really due to parallax, but may be attributable to some unknown cause, having nearly the same period which affected the instruments. Dr. Brünnow is engaged in an additional series of observations which will remove any doubt which might arise on this point.

The report, which contains in addition to these investigations a table of micrometrical measures of double stars and a description accompanied by plates of the newly erected refractor and observatory, does great credit to the industry and zeal of the Dunsink astronomer.

Heat of the Moon.

Lord Rosse has continued successfully his research on the heat of the Moon, and has confirmed his earlier observations of which some account appeared in the last Annual Report. He now finds the percentage of the Moon's heat transmitted by a plate of glass to be 12, while the same plate gives passage to 87 per cent of the solar heat, and only 1·6 per cent of the heat from a body at a temperature of 180°. In these experiments on lunar radiation as the quantity of heat measured by the thermopile represents the difference between the radiation of a circle of sky containing the Moon's disk and a circle of equal diameter of neighbouring sky, the absolute temperature of neither the Moon nor the sky is obtained. In order to obtain information on these points, Lord Rosse has endeavoured to connect the radiation of the sky with that of a body of known temperature, his observations for the apparent temperature of the sky give values varying from 16° to 31°.

Lord Rosse finds that within a limited range of altitude the

heating power of the Moon's rays appears to diminish with the altitude only about one third as fast as the intensity of the solar chemical rays, as ascertained by Roscoe and Thorpe. The Moon's light was observed to diminish with the altitude in the proportion of three to one, but the lunar heat in the proportion of about five to one. As far as can be ascertained from these observations, the maximum of heat seems to occur a little after full Moon.

Colour of Jupiter.

During the last and present oppositions of *Jupiter* colours and markings have been observed on its surface, especially on the belts, by Mr. Browning, and by Dr. Mayer, of Philadelphia. Browning suggests that the coloured appearances may be of a periodic nature; it is hoped therefore that as *Juviter* is now nearly at its greatest north declination, and peculiarly favourable for observation in these latitudes, that a systematic scrutiny of its surface will be undertaken by observers in possession of telescopes of superior optical power. It will be very important to have careful and trustworthy delineations of the planet's disk made from time to time, so that materials may accumulate for the comparison of the appearances of the planet at different epochs.

Royal Observatory, Cape of Good Hope.

Many of the Fellows are aware that Sir Thomas Maclear has resigned the office of Government Astronomer at the Cape of Good Hope, in consequence of declining health, and that the vacancy has been filled up by the appointment of our late valued Secretary, E. J. Stone, Esq.

In the face of the large accumulation of unreduced observations, it appeared to Mr. Stone necessary to somewhat restrict the observing with the transit circle. The observations of stars near the pole had been somewhat confined to close circumpolars. It appeared desirable therefore to extend these observations to stars further from the pole for a check upon the accuracy of the refraction tables employed and the colatitude adopted. It has been thought also that this extension of zero points near the South Pole may be valuable for many purposes, and amongst others for the adjustment of instruments in 1874. A series of such observations has been in progress since October and will be continued for some time. With the present year a systematic reobservation of Sir John Herschel's Cape observations of double stars has been commenced. This will not throw much additional computing labour upon the staff. The first aim of the staff will be to bring forward as soon as possible a standard catalogue of stars, observed with the great transit circle during the years 1856 to 1864. The reductions of the observations made in 1856 have been completed, and it is hoped that the results will shortly be

in the hands of astronomers. The catalogue will contain the places of 328 stars, all well observed. Great praise is due to the assistants generally, but more particularly to Mr. Mann, for the energy with which the somewhat uninteresting and irksome labour of bringing up the heavy accumulation of back work is now being pressed forward.

The vigour with which Mr. Stone has commenced the examination of the great mass of arrears of computations, gives the Council every reason to hope that we shall soon have a standard catalogue of southern stars observed with an instrument comparable with the Greenwich transit circle.

Argentine National Observatory.

The Fellows will receive with gratification the intelligence that an addition has been made to the comparatively small number of astronomical observatories in the Southern hemisphere, and that the new establishment has been placed under the able directorship of our Associate, Dr. B. A. Gould. The Argentine Congress having voted the foundation of a National Observatory at Cordova ($31\frac{1}{2}^\circ$ South latitude), Dr. Gould was invited by the Minister of Public Instruction to organise and take charge of it, pursuing such a scheme of observations as he considered most desirable. Dr. Gould came to Europe in the spring of the past year to procure instruments and books, and went to Cordova in the course of the summer, taking with him four assistants. His first aim will be to extend the survey of the Southern heavens from the limit reached by the zone observations of Argelander (30° S. Decl.) towards the limit of certain as yet unreduced zone observations made by the late Commander Gilliss, extending to about 30° South Polar Distance. All stars down to the ninth magnitude will be included in this survey, and their positions will for the present be made to depend upon the standard star-places determined by Dr. Gould, which form the basis of those given in the American *Nautical Almanac*. Physical observations will be undertaken as far as may be consistent with the energetic prosecution of the before-mentioned task. The Observatory is, or will be, furnished with a Repsold Meridian Circle of $4\frac{1}{2}$-inches aperture, an equatoreal of 11 inches aperture, a spectroscope, and a Zollner's astrophotometer.

Papers read before the Society from February 1870, *to February* 1871.

1870.

Mar. 11. Dark objects crossing the Sun's disk. Lieut. Herschel.
Ephemeris of the Satellites of *Uranus*. Mr. Marth.
Occultation of *m Tauri*. Capt. Noble.
Observation of *Venus* near inferior Conjunction. Capt. Noble.
The Zodiacal Light. Capt. Noble.
On further Changes in the Coloured Belt of *Jupiter*. Mr. Browning.
On the Corona and Zodiacal Light, with suggestions respecting the Observations to be made in December next. Mr. Proctor.

April 8. Observations of Lunar Eclipse, Jan. 7, 1870. Mr. Tebbutt, Jun.
On the Floor of *Plato*. Mr. Birt.
On the Orbit of the Comet of 1683. Mr. Plummer.
On the frequency of Sun-spots, and their Connection with the Magnetic declination variation. Prof. Wolf.

May 13. On some Photographs taken during the Total Solar Eclipse, Aug. 7, 1869. Comm. Ashe.
Some further Observations on η *Argûs* and the surrounding Nebula. Mr. Abbott.
On an early Telescope made by Giuseppe Campani of Rome. Mr. Williams.
On the determination whether the Corona is a Solar or a Terrestrial Phenomenon. Mr. Seabroke.
On *Jupiter's* Satellites. Mr. Severn.
Occultation of *Saturn*, April 19, 1870. Mr. Joynson.
Ditto ditto ditto Mr. Talmage.
Ditto ditto ditto Capt. Noble.
On the Resolvability of Star-Groups regarded as a test of Distance. Mr. Proctor.
On the Proper Motion of *Groombridge* 1830. Mr. Lynn.
Comparison of the Places of the *Tabulæ Red.* and the Radcliffe Catalogue, 1860. Dr. Wolfers.
Note on the above paper. Mr. Stone.
On Meteorological Observations at Gibraltar. Lieut. Brown.
Observations of Occultations of *Saturn*, &c. Mr. Airy.
On η *Argûs*. Mr. Severn.
Loi du Mouvement de Rotation des Planètes. M. Flammarion.
Note respecting the Corona. Prof. Secchi.
Observations at Colebyfield. Mr. Penrose.

June 10. On the Orbit of α *Centauri*. Mr. E. B. Powell.

Note on Father Secchi's Letter to the Academy of Sciences, April 25, 1870. Mr. Seabroke.

Note respecting Solar Spots visible to the Naked Eye. Mr. Hill.

Extract of Letter to Mr. Hind respecting a New Comet. M. Winnecke.

On a Spectroscope in which the Minimum Angle of Deviation and the Prisms are automatically adjusted for the particular Ray of the Spectrum under Examination. Mr. Browning.

On the Alteration in the Colour of the Belts of *Jupiter*. Mr. Browning.

Observations of Winnecke's Comet. Rev. S. J. Perry.

Nov. 11. Further Observations on the Currents of the Solar Photosphere. Mr. Weston.

On the Aurora Borealis of Sept. 24, 1870. Admiral Ommanney.

Observations of Coggia's Comet. Rev. S. J. Perry.

Observations of the Occultation of *Saturn* by the Moon. Mr. Prince.

The Laws of Star Grouping. Mr. Proctor.

On the Use of Screens in Telescopic and other Researches. Mr. Proctor.

On a Contrivance for Extending the Principle of Mr. Browning's Automatic Spectroscope to a Second Battery of Prisms. Mr. Proctor.

On a Standard or Uniform Measure of Time. Col. Drayson.

On a Photograph of *Jupiter*. Mr. Browning.

On the Spectrum of the Aurora Borealis. Mr. Browning.

On a Point in Egyptian Chronology. Mr. Abbe.

On the Automatic Spectroscope for Dr. Huggins. Mr. Grubb.

On the Performance of a Zenith Sector constructed for the Great Trigonometrical Survey, India. Lieut.-Col. Strange.

On Periodical Changes in the Physical Condition of *Jupiter*. Mr. Ranyard.

Dec. 9. On the Proper Motions of 36 A *Ophiuchi* and 30 *Scorpii*. Mr. Lynn.

On the Proper Motion of Oeltzen's Argelander 17415–6. Mr. Lynn.

Observations of Coggia's Comet. Mr. Joynson.

On the Graphical Construction of a Solar Eclipse. Prof. Cayley.

1871. Observations of Solar Eclipse. Baron de Rottenburgh.

Jan. 16. Summary of Sun-spot Observations made at Kew during 1870. Messrs. De La Rue, Stewart, and Loewy.

Solar Eclipse, Dec. 22, 1870. Mr. Joynson.
Ditto ditto Mr. Dancer.
Ditto ditto Rev. Dr. Robinson.
Ditto ditto Mr. Prince.
On a presumed new variable star in *Orion*. Rev. T. W. Webb.
Spots in *Plato*. Mr. Birt.
Solar Eclipse, Dec. 22, 1870. Mr. Talmage.
Ditto ditto Lieut. Brown.
Ditto Dec. 11, 1871. Mr. Ragoonatha Chary.
Ditto Dec. 22, 1870. Prof. C. P. Smyth.
Ditto ditto Rev. S. J. Perry.
Ditto ditto Mr. Ranyard.
Ditto ditto Mr. Plummer.
On the change of colour in the Equatorial Belt of *Jupiter*. Mr. Browning.
Work done at the Kew Observatory. Mr. De La Rue.
Solar Eclipse, Dec. 22, 1870. Lord Lindsay.
Ditto ditto Mr. Stainer.
Ditto ditto Mr. Abbay.
Ditto ditto Mr. Weston.

List of Public Institutions and of Persons who have contributed to the Society's Library, &c. since the last Anniversary.

Her Majesty's Government.
Her Majesty's Government in Victoria.
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Her Majesty's Secretary of State for India.
Royal Society of London.
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Imperial Society, Cherbourg.
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Royal Society, Copenhagen.
Astronomische Gesellschaft, Leipsig.
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Academy of Sciences, Bologna.
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Dr. R. Wolf.
Prof. C. A. Young.

The President, after the conclusion of the reading of the Report of the Council, rose to offer a few observations to the meeting. He said:—

In making the announcement that your Council have not this year been able to recommend the usual award of a Gold Medal, I feel confident you will not attribute the cause to their being unable to find any worthy recipient of it. If that had been the case some ground would have been afforded for the apprehension that the pursuit of the science of astronomy was becoming languid, or followed with less ability. I am happy to say, however, that the cause is a very different one, suggesting rather congratulation than regret.

The mutual dependence of the sciences upon each other has been often remarked, and astronomy has, especially of late, been materially aided in its progress by votaries of other sciences. Thus, some discoveries in astronomy of late years, have scarcely been altogether due to the purely astronomical labourer; and we have had instances in which two or more observers in different departments of science have united in the pursuit of a common object. In these joint labours it is difficult to apportion degrees of merit; and your Council, desirous to recognise to the full this collateral aid, have found it impossible on this occasion to select any individual so pre-eminently distinguished by his own independent researches, that they could recommend the Society to bestow its reward upon him, without danger of doing injustice to others.

This difficulty has repeatedly suggested to your Council the desire to bestow a *joint medal;* but, as the bye-laws of the Society do not appear distinctly to contemplate or sanction such a proceeding, the question has arisen, whether the Society might not on a fitting occasion take into consideration whether or not it would be desirable to introduce any modification of the law relative to the annual award of their Medal.

There is another subject on which, if I may be permitted, I would desire to say a few words.

It seems still to be a matter of doubt in the minds of some astronomers, how many satellites ought to be appropriated to the planet *Uranus*. I venture to think that this is a point worthy of determination with all possible certainty; especially as it may be supposed that with the telescopes we now possess, the requisite observations would neither be very protracted nor extremely difficult.

The long delay which has prevented the completion of the mounting of Mr. Newall's great refractor is much to be regretted; as that telescope may be presumed to be especially fitted, and fully competent for the solution of this problem. The planet has already begun to descend in Northern Declination, and the apparent (or projected) orbits of the satellites to close; though,

in both respects, its position is still highly favourable, and the satellites may be seen in every part of their orbits.

The additional testimony of some competent observer, furnished with a telescope sufficient for the work, would be, I cannot help thinking, worth the very moderate amount of time and labour it would require.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected:—

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